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ABSTRACT

This paper discusses some of the factors that may be relevant to recruitment/retention of minorities into professions. It is based on two assumptions: (1) the job potential in science professions is especially good for minorities; and (2) parity with respect to minorities in science professions is an acceptable goal. Certain factors influencing recruitment/retention in science professions are examined, especially parents, peers, role models, counselors, and teachers. Information is provided to classify the steps these people can take to encourage science career choices among minorities. The author also suggests what lines of research need to be pursued as a basis for better recruitment/retention planning and some of the characteristics of a comprehensive approach to the problem of recruitment/retention. (Author/MA)

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FACTORS RELEVANT TO RECRUITMENT/RETENTION OF MINORITIES IN SCIENCE PROFESSIONS

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Why is it that despite an extensive nationwide recruitment/retention effort, the Committee on Engineering of the National Academy of Science says minority manpower goals in the sciences are not being met? This paper treats some of the factors that may be relevant to recruitment/retention of minorities into science professions. What follows is based on two assumptions: the job potential in science professions is especially good for minorities; parity with respect to minorities in science professions is an acceptable goal. The paper is intended to accomplish three ends: (1) identify possibly relevant factors or variables; (2) suggest what lines of research need to be pursued as a basis for better recruitment/retention planning; (3) suggest some of the characteristics of a comprehensive approach to the problem of recruitment/retention.

While it will be necessary at times to discuss recruitment and retention as separate factors, the reader will soon see that the two are closely connected. If for example, one recruits a student who has poor preparation in mathematics, the probability of retention goes down and the cost effectiveness of the recruitment/retention effort suffers for reasons which are easy to surmise. Figure 1 displays variables of factors which have relevance for a comprehensive educational recruitment/retention program for minorities. While the factors will be discussed in turn, the reader should remember that most of the factors interact with each other to form a complex matrix of associations. Not all members of any particular minority group

Figure 1

Given: Jobs for minorities will be numerous and opportunities for advancement will be good.

Given: Parity with respect to minority participation in science is a valued goal.

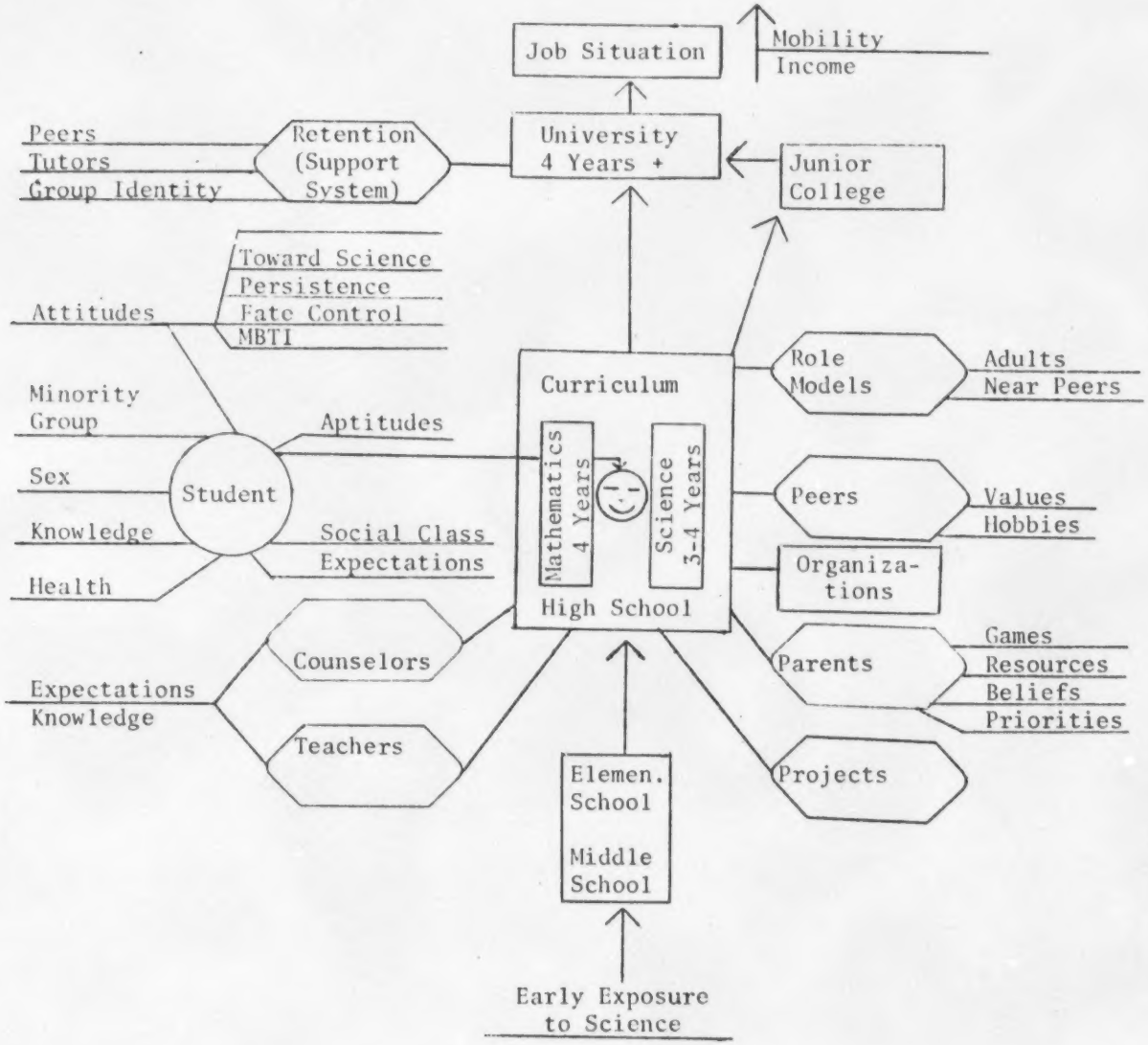
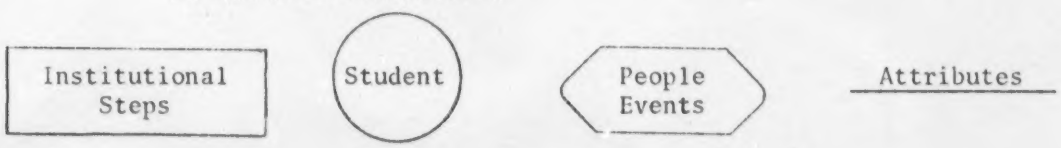


Figure 1. Some Factors Which May Influence Recruitment/Retention in Science Professions.



are poor. Scientists do not usually come from depressed groups. Nevertheless, even among middle and upper-class minority students very few choose science professions. That is the question to which we must attend.

Parents

A program of information and instruction for parents needs to be developed. While the impact which parents have on student choice of careers is not entirely clear, to neglect parents as an important influence probably is foolish. Parents need to know:

1. What kinds of jobs exist in science;
2. What life is like for occupants of science jobs;
3. What income can reasonably be expected;
4. What training requirements must be met;
5. Where to find out more;
6. The relation of science training to leadership;
7. What beliefs they have about science and science careers and how valid they are.

In most communities doctors and dentists are visible. People usually know what they do and how they are making out. Engineers are less visible but they do get some prominence through media ads which describe programs of big companies. Other kinds of scientists get practically no public exposure.

Parent orientation can take place through several agencies:

1. Schools;
2. Community service organizations;
3. Churches;
4. Newspapers and T.V.

There are other things parents can do to help influence basic attitudes, particularly one which will be discussed later (fate control). They can do the following:

1. Provide toys and games which illustrate structure/function relationships. (Rationale for this recommendation appears in the section on fate control.)

2. Take trips to science and industry exhibits and museums.

3. Seek out people in the community who do science and bring them into association with their children.

4. Attach high priority to academic achievement and respect for learning. (Of course, this is to be done with reasonable caution if pressures on students are to remain at reasonable levels.)

5. Encourage schools to provide early exposure to science (elementary grades).

6. Point out people who are prominent in public affairs and/or business that began with a science profession. (The educational program directed to parents might do some of this. Some local initiative would lead to identification of regional examples.)

A multifaceted parent education program needs to be designed. Aspects of such a program could be delivered by out-of-school groups. Other aspects of such a program would be delivered by counselors and teachers. Education of parents while children are still in elementary school will probably be more effective than when children are older and perhaps have already failed to select courses in junior high and high school that will keep the door to science careers open.

Role Models

Students need early access to role models. These models fall into two categories: adults; peers or near-age models. Families which have a scientist in them are more likely to have successive members enter

science. Until the pool of working minority scientists increase this cannot be expected to be a major source of potential scientists and engineers. However, there are now lists of minority scientists. If such people could be brought into association with likely young people, their impact could be considerable. What the nature of this association is, needs some specification. Whether all the desired outcomes that can be supplied by adult models come from members of the same ethnic group is a matter for conjecture - or preferably, for research.

Consider what functions adult scientist role models may supply.

1. Enthusiasm for a kind of job and its desirability for others.

2. Examples of the kinds of thinking and activities which characterize that profession.

3. Project or science club or science hobby advisor (see section on projects).

4. Knowledge of professional realities - study requirements, demands, etc. and evidence (through his/her example) that these are attainable and worthwhile.

5. Social-psychological support for taking an interest in science/math activities.

Bandura's research on the efficacy of models (Stanford University) could reasonably be construed to support the above functions.

The impact that older students who are "making it" can have, needs further examination. Near-peers including those in the late sophomore and junior, senior years at the university may be effective recruiting agents. Their deliberate employment in this kind of function also serves to increase the probability that they will themselves develop increasing

committment as a result of their prosyletizing activities. Thus a plan which includes such people in a recruitment role also has improved retention characteristics. (The committment will grow on the part of the near-peer recruiters, provided they do it voluntarily, and not primarily for pay. e.g., See research of Hovland and of Festinger.)

Near-peers may also serve as role models on a broader spectrum. Younger students can sense their level of committment, their intensity. (See section on peers.) The use of mear-peers in science as tutors and project advisors may provide especially valuabel support when prospective students face difficulties. That is near-peers may become an important factor in persistence.

Peers

One characteristic of young people concerns what is sometimes called "group think." Peer influences are very strong. Departure from the norms of a group can usually occur only at great risk of exclusion. If a student belongs to a group where the recreations, hobbies, conversations, values are relevant to science and engineering kinds of interests then he will usually continue to grow in these and will seek more opportunities to expand knowledge. If inquiry, experimentation, inventing, and academic achievement are not values in the group they are not likely to develop or if they start to flower, may rapidly be extinguished. Thus, for example, in elementary science classrooms we have sometimes seen a youngster accomplish an extraordinary solution to a problem or do an unusual project. If the teacher shows very great enthusiasm for the work, the student might very well get thrashed during lunch break or will suffer considerable teasing until he returns to the norms (Rowe).

Somehow, culturing an ethic of science among minorities means getting small groups of young people into relevant activities together,

i.e., create groups. We do not know much about how to do this so that spontaneity will not be lost but we do know that students who become science buffs generally clump together. Loners often do not survive. If they do,it usually comes about through careful nurturence by some adult. (Roe) (See the section on projects. Also see the section on attitudes and preferences. A substantial number of science students are introverts so will have a more difficult time seeking out people with similar interests).

Counselors

Counselors need continually up-dated science careers information. They may also need to alter their expectations about what minority students can accomplish. Both these issues will be discussed briefly.

a. Information - counselors frequently do not have up-to-date information relevant to career counseling with respect to sciences.

Moreover, there is research concerning personality characteristics which tend to be modal in the various disciplines that might be helpful to a guidance counselor. The Myers-Briggs Type Indicator suggests, for example, that mechanical and civil engineers differ in some important respects from electrical and nuclear engineers. That means both the kinds of science activities that students will find interesting and even the kinds of peer group members that will form compatible support groups will differ. (This will be discussed in somewhat more detail under the section on relevant student attitudes. The MBTI originates from Jungian Theory. Isabelle Briggs Myers and professor Mary McCaulley at the University of Florida school of medicine are two major researchers in this field. Dr. McCaulley particularly has used the MBTI as part of her research among engineering and medical groups). A counseling/teaching program designed with knowledge of the MBTI might be especially valuable to pursue if improved recriutment retention is to take place.

Counselors can play an important part in providing career information to parents as well as to students. In this effort they will probably be more effective if they enlist help from science teachers and from scientists in local industries, businesses and colleges. The problem of course, is to find scientists and then to interest them in the problems of recruitment and retention.

b. Expectation - Counselors frequently are a major factor in determining what people and course resources students can have access to. If counselors do not guard against stereotypic thinking they may counsel minority students out of important courses in science and mathematics, or they may fail to start them into a mathematics sequence early enough. Moreover, counselors often can direct students to clubs and extra-school groups. If counselors communicate a sense of expectation that students would enjoy membership in such groups, prospective minority science students might be encouraged to join such groups. Members of such groups may need help in learning how to effectively absorb additions to the group. (Expectations as a variable that influences all the principal actors will be discussed briefly in the next section on teachers).

Teachers

Four aspects of teacher interaction with students and their influence on recruitment retention will be discussed in this section

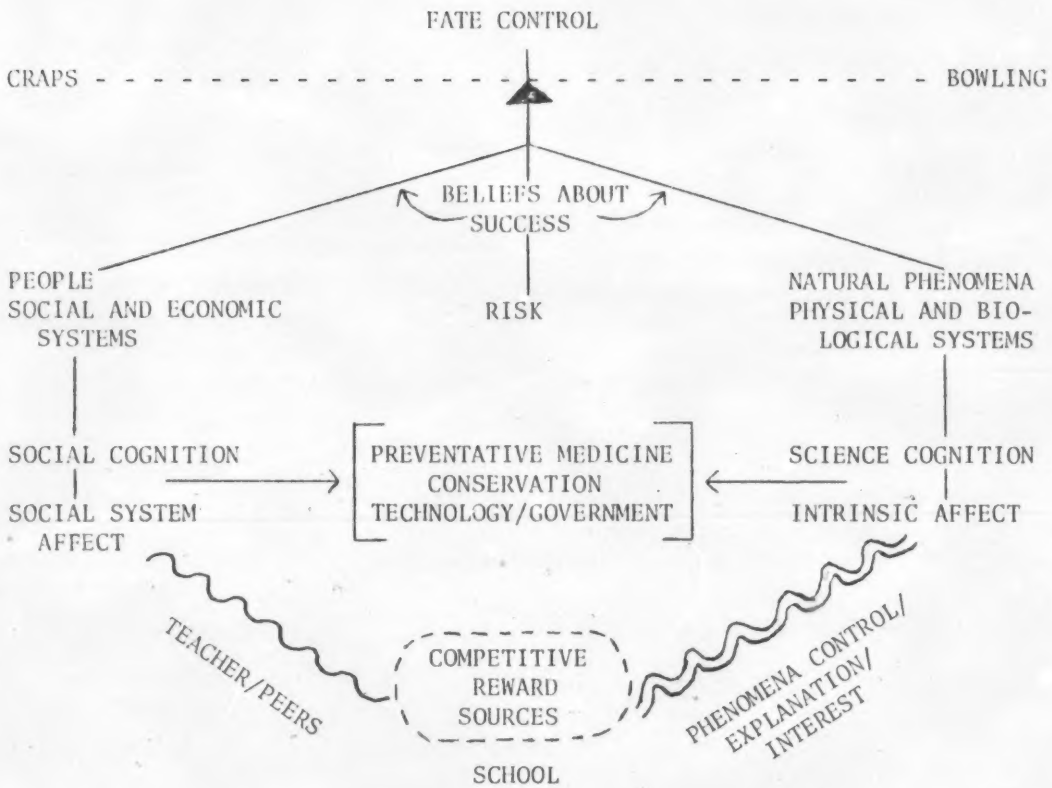
(1) Career guidance functions
(2) Expectations
(3) Projects and club sponsors
(4) Curricular choices

Since science teachers, in contrast to counselors, have almost daily interaction with students, their potential for influence can be very marked, provided they possess up-dated, rather detailed career knowledge. In so far as science teachers come to understand the kinds of demands, actions, functions that different science specialists perform, they can make curriculum more relevant for students. If, in addition, teachers also expect and even demand quality performance from capable minority students, then the probability that more of such students will "make it" increases. Of course, if the demand for performance and high expectations by adults occur early enough in the life of any student and are maintained in accordance with capabilities, the probability that students will value achievement, and persistence increases. Communication of expectations, however, must be honest. Fernandez, Espinosa and Dornbush found that minority students in a large San Francisco high school had been praised in a very unrealistic fashion. Thus, they approached graduation with a very inflated idea of their knowledge and capacities.

There seems to be no doubt that different students get different kinds of access to teachers and to resources in the school. Minority students frequently get less time to respond and receive ambiguous feedback (Rowe);less work is demanded from them and poorer quality is

often graded up (see review by Carl Braun of research on Teacher Expectation; Sociopsychological Dynamics). Teachers, in short, can create a reality that accords with their beliefs. Students tend to mirror that reality. Thus the potential for self-fulfilling prophecy exists in each classroom and over the years accumulates in student minds to eventually produce virtually insurmountable barriers to progress. How can the student-teacher interactive syster be opened up to allow each to operate more effectively? This is an area in which the dynamics of change are in need of research. The fact of differential expectations by both teachers and students is well documented. Obviously, willingness of students to join science project groups and their willingness to take more science and math courses can be influenced by teachers. It remains to be seen whether teachers can influence the persistence of minority students in science. (See figure 1 of Braun's article, figure 2 here, for Braun's summary of factors that influence teacher-student expectations).

Figure


FATE CONTROL
CRAPS
BOWLING
BELIEFS ABOUT SUCCESS
PEOPLE SOCIAL AND ECONOMIC SYSTEMS
RISK
NATURAL PHENOMENA PHYSICAL AND BIO-LOGICAL SYSTEMS
SOCIAL COGNITION
SOCIAL SYSTEM AFFECT
PREVENTATIVE MEDICINE CONSERVATION TECHNOLOGY/GOVERNMENT
SCIENCE COGNITION
INTRINSIC AFFECT
TEACHER/PEERS
COMPETITIVE REWARD SOURCES
PHENOMENA CONTROL/ EXPLANATION/ INTEREST
SCHOOL

Students

All minority groups are not the same. The variables tagged in this paper take on different values in different groups. Some Native Americans, for example, oppose participation by their children in science careers because they hold a view of man's relation to nature which is not the prevailing view in the dominant culture. Kluckholm identified three views of man's relation to nature: man over nature: man in nature; man under or subservant to nature. Man in nature comes closest to the Native American perception. Man under nature is common among many Mexican-American groups (e.g., see the writings of Octavio Paz). On each of the variables identified in this section (see figure 1) research on each ethnic group needs to be pursued with a view to designing appropriate education/recruitment/retention programs. (For convenience the section of figure 1 which relates directly to student factors is reproduced here as figure 3).

A. Attitudes

1. Fate control-One characteristic of scientists is their stance on fate control-the belief that one can, in fact, alter the quality of his life through one's informed participation. Hardy reports in Science that more creative scholars and scientists tend to score higher on one kind of fate control measure (locus-of-control) than do their less creative counterparts.

Briefly, the fate control dimension of attitudes can be described in the following way. Imagine there are two views of how the world functions - the craps model and the bowling model. A person with the craps model sees no relationship between the quantity and quality of his effort and the rewards that come his way. The world is governed by powerful others, unknown forces, whimsical unpredictable conditions that cannot

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be influenced. How things turn out is a matter of luck - good or bad. The craps player believes he cannot change the odds. The bowler, by contrast, knows he can't have perfect control but he believes that according to how he plays the game, uses results to modify behavior, he can up the score (the flow of valued results). The bowler is said to have an internal locus-of-control while the craps player places control external to himself. (For a review of the literature on locus-of-control, see Phares; Joe; Lefcourt). Two people of the same ability level one of whom has the craps orientation and the other a bowler's view, go about problem solving in very different ways. The amount of information they acquire, their persistence, their passivity, their use of cues to alter behavior are markedly different. In his study of Secondary Schools, Coleman found that scores on a locus-of-control measure were the best predictor of achievement for blacks (ahead of ability) and the second best predictor for whites.

Rowe (unpublished) showed that task persistence varied according to whether one scored high on an internality-externality measure. Internals (bowlers) are more persistent than are externals in circumstances which they regard to be potentially controllable. J. Rotter at the University of Connecticut developed the most used locus-of-control measure for adults. Many other measures have since appeared. (See Phares, 1976).

It happens that many poor as well as many minority people tend to score as more external than internal. Rowe has suggested in her NIMH study of problem-solving behaviors of predicted high and low fate control students, that early exposure to science may be especially helpful to minority groups with normal intelligences but which hold a craps model of the world. (Unpublished) Science teaches values that seem to relate directly to perceptions of fate control, e.g., the world is knowable, things can be replicated, i.e., it is not so whimsical after

all, etc., etc. The relation of fate control orientations to choice of science careers, performance, and retention needs much more investigation.

2. Personality Variables-The field of personality research has been a morass for years, at least in so far as redictions related to career choices and performance goes. Lately, however, one measure has emerged as very productive and is increasingly being used as a basis for counseling in health and engineering professions. Results from the Myers-Briggs Type Indicator leads to the supposition that various disciplines or job categories may be thought of as ecological niches in which certain personality types have higher probability of survival than others. (The MBTI identifies 16 personality types. These emerge from 4 scales as shown briefly in Figure 4). M. McCaulley at the University of Florida has identified modal types in the various science professions. Within engineering, for example, the modal types in civil and mechanical engineering are different from those in electrical and nuclear engineering. MBTI types that go eventually into sales and marketing of engineering products differ from those that tend to refer laboratory research. What kind of instructional emphases each cluster of types finds relevant and interesting also differ. From the counseling view, McCaulley says that MBTI patterns are no reason to keep a person out of a discipline but if he possess a rare profile for that profession he ought to know it; the cost of being a rare type can be high. For example, an INTP profile will usually like theory and dislike applied labs. In contrast an ESTJ will like concrete action, will down-grade theory and constantly pushes for practical applications. (Indeed, we can even see these 'types' reflected in engineering curriculum committees and can better understand the origins of Theory/Practice conflicts in program emphases).

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Many, but not all, science students tend to fall on the I side of the extrovert-introvert scale. I people tend to gravitate in higher proportions to natural sciences than to social sciences. At the high school they often cannot find each study because an I does not usually reach out for others and because there are more extroverts. When they get to college and if they choose a science then they discover that they are not "alone". The problem is to help young peer groups that might focus on science things to form early in the high school career.

On the other hand, there are many ESTJ types that go into science. Their problem will arise if they need to spend too much of their time on theory and abstract considerations. Is it possible to strike balances in curriculum or must there be certain route for certain types? Evidence from MBTI studies suggest the latter may be true. Some schools of engineering tend to attract and hold theory-oriented people. Other schools attract and hold a higher proportion of "doer" types. We need more research on a longitudinal nature to show us at what points drop-outs occur and to determine to what extent an MBTI factor may be involved. The results of such an investigation would have consequences both for counseling and curriculum.

We do not know how the MBTI and fate control factors are related. Presumably, if one represents a rare MBTI type in a field then his fate control orientation might need to be more strongly positive than would be the case for modal types.

3. Aptitudes

High quantification aptitude scores are also usually desirable in the sciences. Recent research by McCarthy suggests that people who are high on verbal are not usually high on quantification and conversely. McCarthy

showed that a cluster of other tests also suggest that there may be different V-Q types. That is V and Q people represent distinctive types. Currently we do not know how V-Q is distributed among scientists or specifically within different engineering specialities or what V-Q proportions are most likely to lead to success. Lesser and Stodolsky at Harvard have shown that aptitude patterns relating to verbal, spatial and quantification skills predict which curricular formats will serve which student best, that is, mathematics can be presented in traditional symbol format or in geometric form. High spatial visualizers will learn more rapildy from the latter.

4. Expectations

How do low expectations for success influence student performance? While exactly how expectations make an impact is not entirely clear, the literature review by Brophy and Good (pp. 65-72) suggests that students with low expectation for success are more likely to try to memorize solutions to problems rather than to try to work them out logically.

What factors influence a student's expectations that he will do well in science? Fate control orientations? Knowledge? MBTI? Specific aptitudes? Psychological support from role models and peers? Health? We really do not know how all these factors may interact to result in a student who chooses to study science or to enter a science career. Neither do we know why females in most of the groups are even more prone to eschew science than are males.

Conclusion

A host of research summary agendas have been suggested. But enough knowledge exists from the research to indicate how comprehensive recruitment/instruction/retention programs ought to be designed. Funding sources and project directors have been singularly remiss when it comes to R and D and assessment. Figure 1 identifies the categories of factors that could be important in design, research, and evaluation of programs.

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